

5

10 **METHOD AND CIRCUIT FOR REDUCING DEFECT CURRENT FROM ARRAY
ELEMENT FAILURES IN RANDOM ACCESS MEMORIES**

15

20

25

Inventors: **Richard Parent and David Chapman**

METHOD AND CIRCUIT FOR REDUCING DEFECT CURRENT FROM ARRAY ELEMENT FAILURES IN RANDOM ACCESS MEMORIES

5 This application claims the benefit of provisional patent application serial number 60/458,036 filed on March 27, 2003.

TECHNICAL FIELD

The present invention relates generally to memory chip defect correction and,
10 more particularly, to reducing a standby current contribution due to defects.

BACKGROUND OF THE INVENTION

Conventionally, memory devices, including but not limited to dynamic random access memories (DRAMs), static RAMs (SRAMs), and electrically erasable and
15 programmable read only memories (EEPROMs) are manufactured with a certain amount of spare elements (i.e., "redundant" wordlines and/or bitlines) available for use as replacements for defective wordlines and/or bitlines.

Such an arrangement can allow memory devices (e.g., chips) that include
defects to be fully functional by replacing defective elements with redundant
20 elements. Such defects can arise due to uncontrollable process variations, as but one example. Once defects are replaced, the resulting memory device can have the appearance of an essentially perfect or fully functional chip to an end customer/user.

As would be understood from the above, redundant elements can also significantly improve the device yield, particularly for a product manufactured during
25 the early stages of process development.

A typical memory device can include one or more array regions, each of

which can include memory cells arranged in an array along with wordlines and bitlines connected to such memory cells. In most conventional memory devices, bitlines provide a column-wise access to memory cells while wordlines provide a row-wise access to memory cells.

5 Currently, memory devices can suffer from a variety of failure types that can be repaired by replacing defective elements with redundant elements. Some of the more classical or common types of failures in DRAM devices include: single cell failures, single bitline or wordline fails, bitline-to-bitline shorts, wordline-to-wordline shorts, and wordline-to-bitline shorts. Of course, other types of memory devices can
10 suffer from such defects as well.

After being replaced, different types of failures can have different effects on the operation of a memory device. For example, after being replaced, defective elements may still draw current during operation resulting in a defect current component to overall current consumption in the device.

15 Typically, single cell, single bitlines and single wordline fails do not drain current from the chip supply after being replaced due to the more self-contained nature of these defects.

However, the remaining three failure types: bitline-to-bitline shorts, wordline-to-wordline shorts, and wordline-to-bitline shorts, are usually a main defect current
20 contributor to a DRAM or other memory type design. That is, even though a defective element may be replaced in a logical or functional sense, the defective element may still draw supply current after being replaced.

A conventional methodology for limiting current drawn by replaced defective

elements utilizing current limiter type devices. One example of such a conventional approach is set forth in FIG. 9.

FIG. 9 is a schematic diagram of a portion of a DRAM device designated by the general reference character **900**. Conventional DRAM portion **900** includes a 5 memory cell array section **902**, a complementary bitline pair composed of "true" bitline **904-0** and "complement" bitline **904-1**, and a number of wordlines **906** (WL<3> TO WL<0>). Also shown are a bitline equalization circuit **908** and a sense amplifier circuit **910**.

A bitline equalization circuit **908** can equalize complementary bitline pair (**904-10** 0 and **904-1**) to an equalization voltage (vbleq) prior to a data sense/write operation. In a data sense/write operation, a sense amplifier circuit **910** can amplify a voltage differential between bitlines (**904-0** and **904-1**) and thereby sense a stored data value or drive a write data value. In a standby mode of operation, bitlines (**904-0** and **904-1**) can be maintained at a constant voltage (e.g., vbleq), or may be driven in 15 periodic refresh operations.

If a defect exists within the portion **900**, the portion **900** can be replaced by another redundant section (not shown) of the same DRAM device. However, in the event the defect results in a bitline (**904-0** or **904-1**) being shorted to some other element in the device, a current may be drawn from the equalization voltage source 20 (vbleq).

A conventional approach to limiting the standby current drawn from an equalization voltage source (vbleq) is to include a bitline current limiter device between the bitline equalization circuit **908** and the equalization voltage source

(vbleq). Such a device **912** may be designed (e.g., sized) to limit a maximum amount of current that can be drawn.

In many conventional DRAM applications, a relatively high standby current specification exists, so the above described conventional method can be 5 satisfactory. However, in other types of DRAM designs, newer memory generations, and/or memories for particular low power applications, a standby current specification can be relatively low.

One particular application in which a low standby current can be desirable is a pseudo static random access memory (PSRAM) application. A PSRAM typically has 10 a one transistor (1-T) cell configuration. Thus, a 1-T PSRAM is a one-transistor cell DRAM-type memory designed to emulate other types of SRAMs. A key goal of many 1T-PSRAM designs is maintaining low current during standby mode. Unfortunately, the above described conventional current limiting method can result in undesirably low yields in the case of 1-T PSRAMs, as array type defects can result 15 in an overall standby current (I_{sb2}) that exceeds the lower threshold of a standby current specification.

A standby current in a 1-T PSRAM may have several components:

- (i) I_{ref} : the current required to maintain data in the storage cell capacitor;
- (ii) $I_{circuit}$: the current drained from circuits that must remain active during 20 standby mode;
- (iii) I_{device} : the sub threshold current through all the devices in the design; and
- (iv) I_{defect} : the current due to shorts caused by defects that occur during the

processing of the design.

In light of the above, it would be desirable to arrive at some way of reducing the defect current contribution (i.e., I_{defect}) to overall standby current.

5

SUMMARY OF THE INVENTION

The present invention can include a memory circuit having a plurality of sense amplifiers having a predetermined pitch in a first direction. In addition, a plurality of programmable element controlled devices can be included that each fit within the pitch and isolate an associated bitline from the power supply through a corresponding sense amplifier circuit when disabled.

In this way, if a bitline includes a defect that may draw current from the sense amplifier circuit, such a bitline can be electrically isolated. This can reduce, if not eliminate, a current component introduced by such a defect.

According to one aspect of the embodiments, programmable element controlled devices can comprise n-channel insulated gate field effect (IGFET) transistors laid-out within the pitch of the corresponding sense amplifier.

Such an arrangement can provide isolation capabilities that can be incorporated into existing design without unduly affecting device (e.g., die) size in the sense amplifier pitch direction.

20 According to another aspect of the embodiments, each programmable element controlled device includes a first n-channel IGFET having a source-drain path coupled between a first bitline of a bitline pair and the corresponding sense amplifier, and a second n-channel IGFET having a source-drain path coupled

between a second bitline of the bitline pair and the corresponding sense amplifier.

Such an arrangement can reduce/eliminate defect current in memory device architectures having bitlines arranged into bitline pairs.

According to another aspect of the embodiments, each bitline can be coupled 5 to a plurality of memory cells. Such memory cells can include any from the following list: one transistor dynamic random access memory (DRAM) type cells, magnetoresistive RAM (MRAM) cells, thyristor RAM (TRAM) cells, and ferromagnetic RAM (FRAM) cells.

In this way, the reductions in defect current can be applied to memory devices 10 aimed at low power applications, where such savings may be particularly valuable.

According to another aspect of the embodiments, the bitlines can include folded bitline pairs, each bitline pair of a bitline pair being arranged parallel and adjacent to one another.

In this way, the reduction/elimination of defect standby current can be applied 15 to folded bitline architectures.

According to another aspect of the embodiments, the bitlines can include open bitline pairs, with one bitline of each pair extending over one array section and the other bitline of each pair extending over a different array section.

In this way, the reduction/elimination of defect standby current can be applied 20 to open bitline architectures.

According to another aspect of the embodiments, the bitlines can include unpaired bitlines, each coupled to a sense amplifier circuit that also receives a reference value to compare with a data signal provided by each bitline.

In this way, the reduction/elimination of defect standby current can be applied to single bitline architectures.

According to another aspect of the embodiments, the bitlines can be arranged into logical groups each including a plurality of bitline pairs. In addition, the 5 programmable element controlled devices associated with each logical group are commonly disabled in response to the same control signal.

In this way, bitlines can be isolated in a group-wise fashion. Such an arrangement may be more compatible with many existing redundancy approaches that disable groups of bit lines in a replacement/repair operation.

10 The invention may also include a method of reducing a standby current contribution in conductive lines of a memory device. The method includes providing at least one transistor between each of a plurality of conductive lines arranged in a first direction within a memory cell array and a corresponding circuit coupled to the conductive line. A fuse-type element can be programmed to generate a control 15 signal first value if an associated conductive line is determined to have a defect. The method also includes disabling each transistor when the associated control signal has the first value to prevent the standby current from flowing through the transistor from the corresponding conductive line.

In this way, conductive lines can be isolated according to a fuse-type element, 20 enabling such conductive lines to be isolated in an essentially permanent fashion.

According to another aspect of the embodiments, the step of programming a fuse-type element is performed in a wafer test procedure.

Such an arrangement can allow such isolation programming to be performed

with other wafer test programming (e.g., redundancy programming).

According to another aspect of the embodiments, the step of providing at least one transistor includes providing at least one transistor between a bitline and a corresponding sense amplifier circuit. More particularly, such a transistor can be provided between an equalization circuit within the sense amplifier circuit and a corresponding bit line. Alternatively, such a step can include providing at least one transistor between a wordline and a corresponding wordline driver circuit.

The present invention can also include a circuit for reducing standby current in a memory device. The circuit can include a plurality of first conductive lines parallel to one another, each first conductive line coupled to a plurality of memory cells in a memory cell array. A plurality of first circuits can be arranged on at least one side of the memory array, each first circuit coupled to at least one associated first conductive line and having a same first pitch in a first direction. A plurality of first isolation circuits can be included that each permanently isolates a corresponding first circuit from the associated at least one first conductive line when activated. Each first circuit can fit within the first pitch.

According to one aspect of the embodiments, a plurality of first conductive lines can include bitlines commonly coupled to memory cells of the same column in the memory cell array. In addition, the plurality of first circuits can include sense amplifier circuits for driving an associated bitline according to a data value on such bitline.

In addition or alternatively, a memory device can include wordlines commonly coupled to memory cells of the same row in the memory cell array. Second isolation

circuits can isolate wordline driver circuits from such wordlines.

According to another aspect of the embodiments, a circuit can also include at least one fuse circuit for providing an activation signal according to the state of at least one fuse-type element. Each isolation circuit can include at least one transistor. Such a transistor can have a gate coupled to the activation signal.

According to another aspect of the embodiments, the isolation circuit can include a plurality of transistors having gates commonly coupled to the activation signal.

According to another aspect of the embodiments, a fuse-type element is selected from the group consisting of: a fusible link alterable to have a conducting or a non-conducting states, an anti-fuse structure alterable to have a conducting or a non-conducting states, an electrically programmable memory cell programmable to have a conducting or a non-conducting states.

15

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block schematic diagram of a first embodiment of the present invention.

FIG. 2 is a top plan view of a second embodiment of the present invention.

FIG. 3 is a schematic diagram of a third embodiment of the present invention.

20 FIG. 4 is a block schematic diagram of a fourth embodiment of the present invention.

FIG. 5 is a block schematic diagram of a fifth embodiment of the present invention.

FIG. 6 is a block schematic diagram of a sixth embodiment of the present invention.

FIG. 7 is a block schematic diagram of a seventh embodiment of the present invention.

5 FIG. 8 is a flow diagram of a method according to another embodiment of the present invention.

FIG. 9 is a schematic diagram showing a portion of a conventional DRAM device.

10 DETAILED DESCRIPTION

Various embodiments of the present invention will now be described in detail with reference to a number of drawings. The embodiments include circuits and methods for reducing a defect current component of a standby current. The method and circuits can isolate conductive array lines containing defects from potential
15 current sources.

A first embodiment of the present invention is a circuit that can isolate complementary bitline pairs from current sourcing circuits, such as those included in an associated sense amplifier circuit. A first embodiment is shown in FIG. 1 and designated by the general reference character **100**.

20 FIG. 1 shows a portion of a memory device that includes a bitline pair, including a "true" bitline (BL) **102-0**, a "complement" bitline (BL_) **102-1** connected to a sense amplifier circuit **104** by controllable device circuit **106**. Controllable device circuit **106** can be controlled according to a permanent option circuit **108**. Further, a

sense amplifier circuit **104** can provide an output to other data path circuits, such as a column decoder **110**, as but one example.

In the embodiment of FIG. 1, controllable device circuit **106** can include controllable devices (**112-0** and **112-1**) connected between each bitline (BL and its complement, BL_) and associated sense amplifier circuit **104** (Sense Amp).

High-density memory designs, such as dynamic random access (DRAM) type designs can result in a relatively compact layout arrangement. Further, sense amplifiers circuits (e.g., **104**) can be a repeated structure that results in a sense amplifier "pitch" that may limit at least one chip dimension.

Thus, it is desirable for any additional devices corresponding to sense amplifier circuits to fit within a sense amplifier pitch, typically defined according to an optimal sense amplifier layout design. Thus, while the embodiment of FIG. 1 provides controllable devices (**112-0** and **112-1**) capable of switching a leakage current path on and off, a feature of the embodiment is that such devices fit within a sense amplifier pitch. To meet such a layout restriction, the embodiment of FIG. 1 includes n-channel metal-oxide-semiconductor (MOS) type transistors as controllable devices (**112-0** and **112-1**) sized to fit within one sense amplifier pitch.

A sense amplifier circuit **104** may include not only a sense amplifier, but additional circuits as well, including but not limited to a precharge circuit and/or equalization circuit. Accordingly, a sense amplifier circuit **104** can provide a leakage current source (or sink) in the event a defect occurs that affects either or both bitlines (**102-0** and **102-1**).

A column decoder **110** can include a data path enabled in response to a

decoder signal YDEC. A decoder signal YDEC may be activated in response to an applied address.

A permanent option circuit **108** can provide a disable signal (DIS_) to controllable device circuit **106**. If bitlines (**102-0** and **102-1**) are determined to be

5 defect free, or free from current drawing defects, a disable signal (DIS_) can remain in an active state (high), thus enabling a current path between bitlines (**102-0** and **102-1**) and the sense amplifier **104**. If bit lines (**102-0** and **102-1**) are determined to be affected by a defect, a permanent option circuit **108** can drive disable signal (DIS_) to an inactive state (low), isolating bitlines (**102-0** and **102-1**) from

10 corresponding sense amplifier circuit **104** by operation of controllable device circuit **106**.

It is understood that permanent option circuit **108** can provide a disable signal in an essentially permanent fashion. That is, once configured to provide an active disable signal (DIS_), permanent option circuit **108** will continue to provide such a

15 signal at essentially all times that power is supplied to the device. That is, the active disable can be permanent. As will be described in more detail below, such a permanent option can be achieved by a number of options, such as one or more programmable elements, like fusible links as but one example.

In this way, a first embodiment can isolate leakage paths flowing through

20 bitlines in an essentially permanent fashion, thus reducing if not eliminating any defect current component introduced by such bitlines. Thus, permanent option circuit **108** can operate in a clearly different fashion than decoder circuits and conventional redundancy circuits that generate signals in response to an applied

address.

While the above first embodiment shows one example where bitlines are isolated from a current source, such an approach may be used to isolate all or certain groups of memory device lines from associated circuits. One such approach
5 is shown in FIG. 2.

FIG. 2 is a top plan view showing a memory device having isolation devices for multiple types of circuits. Memory device **200** can include a memory cell array **202** having a memory cells (not shown) arranged in a matrix, or the like. Various conductive lines can be arranged within the array, connected to the memory cells.

10 FIG. 2 shows bitlines **204** arranged in a first direction over memory cell array **202**. Only a portion of the bitlines **204** is shown, it being understood that such bitlines can extend over essentially all of the array in one direction (vertically in FIG. 2). Bitlines **204** can be connected to a number of memory cells, such as a column of memory cells.

15 FIG. 2 also shows a second set of conductive lines: wordlines **206** arranged in a second direction over memory cell array **202**. Again, only a portion of the wordlines **206** is shown, it being understood that such wordlines can extend over essentially all of the array in one direction (horizontally in FIG. 2). Wordlines **206** can be connected to a number of memory cells, such as a row of memory cells.

20 Memory cell array **202** can include redundant columns **208** as well as redundant rows **210**. A redundant column **208** (or group of redundant columns) can be used to replace a normal column (or group of normal columns). Similarly, a redundant row **210** (or group of redundant rows) can be used to replace a normal

row (or group of normal rows).

One side of memory cell array **202** can be conventional circuits for accessing memory cells in a column-wise fashion. In particular, one side of memory cell array **202** can include sense amplifiers **212** along with redundant sense amplifiers **214**,
5 and column decoders **216** along with redundant column decoders **218**.

However, unlike conventional memory device arrangements, memory device **200** also includes first controllable disable circuits **220** situated between bitlines **204** and sense amplifier circuits (**212** and **214**).

FIG. 2 includes a magnified view **222** of one side of memory cell array **202**.

10 The magnified view **222** shows how an arrangement like that of FIG. 1 can be repeated in a column wise direction. Shown in magnified view **222** are bitlines **204** connected to sense amplifier circuits (one of which is labeled **212-y**) by first controllable disable circuits (one of which is labeled **220-y**). Magnified view **222** also shows a sense amplifier circuit pitch **224**, and illustrates how first controllable disable
15 circuits **220** each fit within such a first pitch **224**.

Referring still to FIG. 2, a second side of memory cell array **202** can include conventional circuits for accessing memory cells in a row-wise fashion. In particular, a second side of memory cell array **202** can include wordline driver circuits **226** along with redundant wordline driver circuits **228**.

20 However, unlike conventional memory device arrangements, memory device **200** also includes second controllable disable circuits **230** situated between wordlines **206** and wordline driver circuits (**226** and **228**).

FIG. 2 includes a magnified view **232** of the second side of memory cell array

202. The magnified view **232** shows how second controllable disable circuits can be repeated in a row wise direction. Shown in magnified view **232** are wordlines **206** connected to wordline driver circuits (one of which is labeled **226-x**) by second controllable disable circuits (one of which is labeled **230-x**). Magnified view **232** also 5 shows a wordline driver circuit (e.g., a second) pitch **234**, and illustrates how second controllable disable circuits **230** each fit within such a second pitch **234**.

In this way, a memory device can include first controllable disable circuits for isolating defective first conductive lines (e.g., bitlines) from drawing a defect leakage current, or can include second controllable disable circuits for isolating defective 10 second conductive lines (e.g., wordlines) from drawing a defect leakage current, or can include both.

A third embodiment of the present invention will now be described with reference to FIG 3.

FIG. 3 is a detailed schematic diagram of a circuit that can isolate a 15 complementary bitline pair from a sense amplifier circuit. The third embodiment is designated by the general reference character **300**, and shows a portion of a memory cell array **302**, an isolation circuit **304**, a sense amplifier circuit **306**, and a permanent option circuit **308**.

Memory cell array portion **302** shows a number of memory cells (one of which 20 is shown as **310**) arranged in a matrix, a complementary bitline pair (**312-0** and **312-1**), as well as wordlines **314-0** to **310-3**. A memory cell array portion **302** may preferably draw a lower amount of power than other memory cell array type. Accordingly, in the embodiment of FIG. 3, a memory cell array **302** can be a DRAM

type array, suitable in a low power DRAM device or a pseudo-SRAM device.

The present invention can be particularly applicable to low-power applications in which defect induced currents can be a considerable issue. Accordingly, a memory cell array **302** could include other types of memory cells for lower power devices, including but not limited to magneto resistive RAM (MRAM) cells, thyristor RAM (TRAM) cells, and ferromagnetic RAM (FRAM) cells.

Of course, the present invention could also be applied to other types of memory devices, including but not limited to those that include static RAM (SRAM) type cells and electrically erasable programmable read-only-memory (EEPROM) cells.

Isolation circuit **304** can include two n-channel transistors (M1 and M2) arranged in parallel with one another. A first n-channel transistor M1 can have a source-drain path arranged between a “true” bitline **312-0** and a first sense amplifier circuit node N1. A second n-channel transistor M2 can have a source-drain path arranged between a “complement” bitline **312-1** and a second sense amplifier circuit node N2. Gates of both transistors (M1 and M2) can be controlled according to a bitline disable signal (bldisable).

A sense amplifier circuit **306** can include an equalization circuit **316** and a sense amplifier **318**. An equalization circuit **316** can be enabled and disabled according to an equalization signal (bleql). When enabled (e.g., bleql high), equalization circuit **316** can essentially short the bitlines (**312-0** and **312-1**) to one another, and provide an equalization voltage (vbleq) to the bitlines (**312-0** and **312-1**). When disabled, (e.g., bleql low), equalization circuit **316** can present a high

impedance between the bitlines (312-0 and 312-1). A sense amplifier 318 can amplify a differential voltage appearing between bitlines (312-0 and 312-1) when enabled by sense amplifier enable signals (setp and setn).

A permanent option circuit 308 can establish a bitline disable signal

5 (bldisable) in an essentially permanent fashion. The particular permanent option circuit 308 of FIG. 3 can include a latch 320 composed of cross-coupled inverters. A latch 320 can have an output that provides bitline disable signal (bldisable) and an input connected to a set node N3. A potential at set node N3 can be established according to reset device 322 and programmable element 324. A reset device 322

10 can be weak pull-up device activated according to a reset signal. In the particular case of FIG. 3, a reset device 322 can include a p-channel transistor. A programmable element 324 can be programmed to provide a relatively low impedance or high impedance path with respect to node N3. In the particular case of FIG. 3, a programmable element 324 can include a fusible link that can be opened

15 ("blown") via laser irradiation, or other methods.

In operation, if programmable element 324 presents a low impedance, when a reset signal pulses low, reset device 322 will not overpower programmable elements 324, and latch 320 will latch a high bitline disable signal (bldisable).

Conversely, if programmable element 324 presents a high impedance, when a reset

20 signal pulses low, reset device 322 will pull set node N3 high, and latch 320 will latch a low bitline disable signal (bldisable).

Of course, the present invention should not be limited to any particular programmable element type. While, FIG. 3 illustrates a fusible link, other option

techniques could be used, including but not limited to laser blown fuses, current blown fuses, anti-fuses, and electrically programmable elements, such as EEPROM cells, and the like.

The operation of the circuit of FIG. 3 will now be described.

5 After a memory device has been manufactured, such a memory device can be tested to determine if any defects are present that affect bitlines and/or wordlines. If such a defect is detected that affects a bitline (**312-0** or **312-1**, or both), such bitlines (**312-0** or **312-1**, or both) may be replaced by operation of conventional redundancy techniques.

10 However, unlike conventional redundancy approaches, a programmable element **324** can be set to a non-conducting (high impedance) state (i.e., the fuse can be blown). Accordingly, when a reset signal pulses low, the output of latch **320** can be driven low, and bitline disable signal (bldisable) can be low.

With bitline disable signal (bldisable) low, transistors M1 and M2 within
15 isolation circuit **304** can be turned off, isolating bitlines (**312-0** or **312-1**) from sense amplifier circuit **306**, and hence isolating bitlines from a potential current source/sink.

One skilled in the art would recognize that the above embodiments have illustrated a “folded” bitline arrangement, in which true and complementary bitlines are arranged adjacent to one another. The present invention should not necessarily
20 be limited to such a configuration. Two of the many possible variations are shown in FIGS. 4 and 5.

FIG. 4 shows an “open” bitline configuration. FIG. 4 can include some components corresponding to those set forth in FIG. 3. Accordingly, like

components will be referred to by the same reference character but with the first digit being a "4" instead of a "3".

FIG. 4 shows a portion of a memory device **400** and includes a sense amplifier circuit **406**. Sense amplifier circuit **406** can be isolated from associated 5 bitlines (**412-0** and **412-1**). However, a true bitline **412-0** can be formed over a first array portion **402-a** while a complement bitline **412-1** can be formed over a second, different array portion **402-b**. Thus, within isolation circuit **404**, a first n-channel transistor M1' can be situated between a first array portion **402-a** and sense amplifier circuit **406**, while a second n-channel transistor M2' can be situated 10 between a second array portion **402-b** and sense amplifier circuit **406**.

FIG. 5 shows a single bitline configuration. FIG. 5 can include some components corresponding to those set forth in FIG. 3. Accordingly, like components will be referred to by the same reference character but with the first digit being a "5" instead of a "3".

15 FIG. 5 shows a portion of a memory device **500** and includes a sense amplifier circuit **506**. In the arrangement shown, only one bitline **512** can be associated with a sense amplifier circuit **506**. Accordingly, an isolation circuit **504** can include one n-channel transistor M1" having a source-drain path between bitline **512** and its associated sense amplifier circuit **506**.

20 Such an arrangement may be utilized in memory devices that typically include single bit lines, such as some EEPROMs architectures. It is understood that sense amplifier circuit **506** would receive a reference value for comparison with a data value from the associated bitline. For example, if sense amplifier circuit **506**

includes a voltage sense amplifier, sense amplifier circuit **506** can receive a reference voltage. Similarly, if sense amplifier circuit **506** includes a current sense amplifier, sense amplifier circuit **506** can receive a reference current.

It is understood that while some of the embodiments have illustrated a single
5 bitline, bitline pair, or single wordline, the present invention can include the disabling
such conductive lines in a group-wise fashion.

Two examples of group-wise isolation of defect induced current are shown in FIGS. 6 and 7. FIG. 6 shows a portion of memory device **600** and includes similar components to FIG. 3. Accordingly, like components will be referred to by the same
10 reference character but with the first digit being a "6" instead of a "3".

Memory device portion **600** shows multiple isolation circuits **604-0** to **604-n** that commonly isolate bitline pairs **612-00/01** to **612-n0/n1** from corresponding sense amplifier circuits **606-0** to **606-n**, respectively. In such an arrangement, when bitline disable signal (BLDISABLE) is low (due to a permanent option circuit), any
15 defect induced current that would flow on any of bitlines (**612-00/01** to **612-n0/n1**) can be essentially eliminated. Such an arrangement may be applicable to redundancy schemes that enable/disable groups of bitlines (e.g., groups of columns).

It is noted that a group of commonly activated isolation circuits (**604-0** to **604-n**) need not be adjacent to one another. In many architectures, a group of redundant bitlines may replace a group of normal bit lines that are spaced from one another within an array (e.g., every fourth bitline, every eighth bitline, etc...). Thus, while FIG. 6 shows multiple isolation circuits (**604-0** to **604-n**) adjacent to one another, the

invention is by no means limited to such an arrangement.

FIG. 7 shows a portion of memory device **700** including wordline driver circuits (**702-0** to **702-m**) connected to corresponding wordlines (**706-0** to **706-m**) by isolation circuits (**704-0** to **704-m**), respectively. Each wordline (**706-0** to **706-m**) can
5 be commonly connected to a row of memory cells, one of which is shown as **708**. Each isolation circuit (**704-0** to **704-m**) can include an n-channel transistor, the gates of such transistors being commonly connected to a wordline disable signal (WLDISABLE). In such an arrangement, when wordline disable signal (WLDISABLE) is low (due to a permanent option circuit), any defect induced current
10 that would flow on wordlines (**706-0** to **706-m**) can be essentially eliminated. Such an arrangement may be applicable to redundancy schemes that enable/disable groups of wordlines (e.g., groups of rows).

As in the case of the FIG. 6, commonly activated isolation circuits (**704-0** to **704-m**) need not be adjacent to one another.

15 The above embodiments have described arrangements in which permanent isolation of conductive lines may be accomplished by setting the state of a programmable element, such as a fuse. Such programming can preferably be done as part of a wafer test procedure (i.e., a test performed at wafer level as opposed to a single sliced die or a packaged die). Such an arrangement can be preferable
20 because at this stage other programming can be performed, such as an initial redundancy programming step (prior to a determination that any redundant elements may be defective).

It is also noted that in either a bitline defect case or wordline defect case, the

defective element portion that is cut-off (e.g., isolated) may have some initial floating as the element is no longer actively driven by a sense amplifier circuit or the wordline driver circuit. But, based upon the particular type of defect, such an element portion may be resistively tied to another element (e.g., the other bitline in a 5 bitline-to-bitline short or the other wordline in a wordline-to-wordline type of short) and as a result, no DC current will flow through. Thus, the standby current contribution can be essentially eliminated from this particular defective element.

A method for isolating defective bitlines and/or wordlines will now be described with reference to FIG. 8. FIG. 8 is a flow diagram **800** of a general wafer 10 test procedure. FIG. 8 includes performing a wafer test (step **802**). Such a step can include executing a number of predetermined electrical tests on automatic test equipment (ATE) to determine if any memory devices on the wafer include a defect (step **804**).

If there are no defects, a wafer may be sliced and packaged. If a defect is 15 found, repair may be attempted according to type of defect. If a defect is a column defect (step **806**), a defective column (or columns) can be replaced (step **808**). Unlike conventional testing arrangements, defective bitlines can be permanently isolated from associated sense amplifier circuits (step **810**).

If a defect is a row defect (step **812**), a defective row (or rows) can be 20 replaced (step **814**). Further, and again, unlike conventional testing arrangements, defective wordlines bitlines can be permanently isolated from associated wordline driver circuits (step **816**).

If other defects remain present (step **818**), such defects can be fixed, if

feasible (step 820), otherwise the device having such additional defect can be marked as defective (i.e., "inked") (step 822).

Repaired devices may then be retested (step 826), and if defects remain, such devices can be marked as defective (step 822).

5 Of course, the method shown in FIG. 8 represents but one approach, and so should not be construed as limiting the invention thereto. As but one example, only bitline isolation or only wordline isolation may be performed.

The embodiments disclosed herein can provide advantages over other known approaches by eliminating the standby power due to certain array type defects. The
10 embodiments described can utilize on-pitch programmable element (e.g., fuse) controlled devices to isolate defects. This approach can be valuable for memory devices (e.g., DRAMs) for use in a low current applications.

The methods and apparatuses of the embodiments may be best suited for use in emerging process technologies and where the yield benefit analysis favors
15 the additional fuse area approach.

Many of the embodiments above have shown the use of n-channel transistors for isolating conductive lines from current source/sink circuits. However, the particular conductivity of such transistors should not necessarily be construed as being limited to n-type.

20 Further, in the case n-channel transistors are employed as isolation devices, it may be desirable to drive the gates of such devices with a "booted" voltage (a voltage higher than that achievable by a sense amplifier) in order to limit any limitations in maximum voltage presented by the inherent threshold voltage of such

devices.

It is understood that other embodiments of this invention may be practiced in the absence of an element/step disclosed or not specifically disclosed herein.

Accordingly, while the various aspects of the particular embodiments set forth
5 herein have been described in detail, the present invention could be subject to various changes, substitutions, and alterations without departing from the spirit and scope of the invention.

10